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Request for grant of a patent

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1.	Your reference	**AJF/P64228/000**
2.	Patent application number *(The Patent Office will fill in thi[s part])*	0322132.2 — 22 SEP 2003 — 23SEP03 E839027-1 D02882 P01/7700 0.00-0322132.2
3.	Full name, address and postcode of the or of each applicant *(underline all surnames)*	**SYNAD TECHNOLOGIES LIMITED** **1650 ARLINGTON BUSINESS PARK** **THEALE** **READING** **BERKSHIRE** **RG7 4SA**
	Patents ADP number *(if you know it)*	8268690004
	If the applicant is a corporate body, give the country/state of its incorporation	**UNITED KINGDOM**
4.	Title of the invention	**METHOD OF DATA HANDLING IN A WLAN**
5.	Name of your agent *(if you have one)*	**BOULT WADE TENNANT**
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	**VERULAM GARDENS** **70 GRAY'S INN ROAD** **LONDON WC1X 8BT**
	Patents ADP number *(if you know it)*	**42001** ✓

		Country	Priority application number (if you know it)	Date of filing *(day/month/year)*
6.	If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number			

		Number of earlier application	Date of filing *(day / month / year)*
7.	If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application		

8.	Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:* *a) any applicant named in part 3 is not an inventor, or* *b) there is an inventor who is not named as an applicant,* *or* *c) any named applicant is a corporate body.* *See note (d))*	**YES**

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Continuation sheets of this form	0
Description	9
Claim(s)	3
Abstract	0
Drawing(s)	2

x2

10. If you are also filing any of the following, state how many against each item.

Priority documents	0
Translations of priority documents	0
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	0
Request for preliminary examination and search *(Patents Form 9/77)*	0
Request for substantive examination *(Patents Form 10/77)*	0
Any other documents *(Please specify)*	0

11 I/We request the grant of a patent on the basis of this application.

Signature Date

22 September 2003

12. Name and daytime telephone number of person to contact in the United Kingdom

Dr. Alex Frost
020 7430 7500

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Method of Data Handling in a WLAN

This invention relates to a modified method of data transmission and receipt acknowledgement in a Wireless Local Area Network (WLAN) and, in particular, to modifications to the manner of frame transmission and acknowledgement in the current IEEE 02.11 Standards.

The IEEE 802.11 Standard specifies a Medium Access Control (MAC) layer which, amongst other functions, manages access to a medium (i.e., a shared radio channel) by nodes in the WLAN such as WLAN clients or access points (APs). The 802.11 MAC layer uses an 802.11 physical (PHY) layer such as 802.11a or 802.11b, to perform the tasks of carrier sending, transmission and receiving of 802.11 data.

Data in the 802.11 Standard is divided into frames, each of which contain, for example, timing and destination information in header portions (a MAC Leader and a PLCP Leader), along with a data payload. Before the frames are transmitted, a station wishing to transmit must first gain access to the (shared) medium. Two forms of medium access are defined in the 802.11 Standard, Distributed Coordination Function (DCF) and Point Coordination Function (PCF). DCF is mandatory and is based upon a carrier sense multiple access with collision avoidance (CSMA/CA) protocol. With DCF, 802.11 stations contend for access and attempt to send frames when there is no other station transmitting. If another station is sending a frame, then stations wait until the channel is free.

There are various timing considerations in the 802.11 Standard. For example, stations accessing the network calculate the time necessary to send a frame (based upon the frame's length and the data rate) and this information is held in the duration field of that frame's header, prior to transmission of the frame. Stations in the network maintain a Network Allocation Vector (NAV) which determines when a frame is sent by a given station. The duration fields of received frames are examined by stations and these set that station's NAV.

In addition to the frame duration timing, the DCF also employs a random back-off timer which is used by a station when a busy medium is detected.

In the channel is in use, then a random delay is introduced before the station tries to access the medium again. This ensures that there is no repeated collision as would occur if multiple channels were repeatedly to check and attempt to access the medium at the same time. The back-off timer significantly reduces the number of collisions, particularly when there are larger numbers of active stations.

WLAN stations cannot simultaneously listen for collisions and transmit (mainly because a station cannot transmit and receive at the same time). To address this, an acknowledgement (ACK) must be sent by the receiving station once it has received the transmitted frame without errors. The receiving station waits for a short period known as a Short Inter Frame Space (SIFS) before transmitting the ACK. The transmitting station assumes that there has been

a collision (or RF interference) if an ACK is not received within a specified time.

There are a number of problems with the present arrangement. The medium is not used during the SIFS period which follows receipt of the data frame by a receiving station. The medium also cannot be used for data transfer during the subsequent ACK transmission period. Furthermore, the use of a random back-off timer, whilst reducing the number of collisions, does mean that random delays can constitute a significant proportion of the available transmission time, causing a reduction in transmission capacity.

To address the problem of delays caused by the random back-off timer, 802.11 implementations have increasingly employed a technique known as "frame bursting". This is illustrated in Figure 1, which shows the transmission and reception channels 10, 20 of a first WLAN station, configured to process frames using frame bursting.

As is seen in Figure 1, the first WLAN station gains control of the medium, using the contention mechanism described above, after a random time introduced by the random back-off timer. A first data frame 30 is then transmitted. After a SIFS 40, an acknowledgement frame 50 for a previously transmitted data frame (not shown) is received in the reception channel 20. However, in this burst mode, instead of waiting a random time before sending a next data frame, the station instead starts transmission of that next data frame 60 immediately after a further SIFS 70. The station thus retains control of the

medium and other stations are in consequence prevented from starting transmissions until the burst has ended. The burst concludes when a maximum burst length is exceeded (to prevent one station from controlling the medium indefinitely) or when the transmitting station runs out of frames to send.

Frame bursting thus reduces the amount of random time periods introduced in order to prevent collisions, although of course, it does not dispense with them completely as a contentions mechanism is still necessary to decide which station will next have control of the medium following completion of a previous burst. However, frame bursting does still suffer from problems. In particular, a transmitting station often runs out of frames to send in a given burst because the majority of data sessions are to some extent bi-directional. In other words, in order for a transmitting station to continue to have transmittable frames, it must first have received return data (usually from the intended recipient station) in the reverse direction. As a result, frame bursts are often shorter than is desirable because the transmitting station runs out of frames to send.

The present invention is concerned with these and other problems with current WLAN protocols.

Against this background, there is provided a method of handling data packets in a Wireless LAN network comprising: receiving, at a first node in the network, an incoming data packet from a second node in the network; preparing an acknowledgement of receipt by the first node, for return to the second

node, when the incoming data packet is received at the first node; and when it is ascertained that there is at least one outgoing data packet at the first node and which is intended for transmission to that second node, concatenating the acknowledgement of receipt with the or at least one of the outgoing data packets intended for that second node, for transmission as a combined data/acknowledgement packet to the second node.

In other words, the 'pay load' data which is queued at the first node and is to be sent to the second node anyway is 'piggybacked' onto the acknowledgement of receipt which is usually (but not always) requested by the second node and which needs to be sent by the first node. This provides an improved throughput of data relative to the prior art 'bursting' technique since payload data and acknowledgements of receipt can be sent simultaneously in certain circumstances.

The invention is particularly applicable to Transport Control Protocol/Internet Protocol (TCP/IP) traffic on a network. **[why?]**

The present invention may be put into practice in a number of ways and one specific embodiment will now be described by way of example only and with reference to the accompanying Figures in which:

Figure 1 shows how data is handled in the transmission and reception channels of a node in a wireless LAN, using conventional frame bursting techniques; and

Figure 2 shows, schematically, how data is handled by the transmission and reception channels of first and second nodes in a wireless LAN, in accordance with an embodiment of the present invention.

Referring to Figure 2, the transmission channel 100 and reception channel 110 of a first node of a wireless LAN is shown schematically. Figure 2 also shows a transmission channel 200 and a reception channel 210 of a second node in that wireless LAN.

In accordance with an embodiment of the present invention, instead of sending separate acknowledgement and "payload" frames, "payload" data intended for transmission to a particular other node in the network is instead piggybacked onto an acknowledgement frame that needs to be sent to that particular node anyway as an acknowledgement of receipt for a data frame sent previously from that other node. A particular scheme for doing this will now be described, again by way of example only, still referring to Figure 2.

A first node receives a "standard" 802.11 data frame 120 with a PLCP head 130 from the second node in the network, after a random delay. The random delay is, as with the conventional frame bursting method, used as part of a contentious procedure for allowing a particular node, in this case, node 1, to gain control of the medium. As will be seen in Figure 2, the data frame received in the reception channel 110 from the second node is labelled data frame X.

Node 1, upon receipt of the data frame X 120 with its PLCP header 130 firstly checks to see whether node 2 has requested an acknowledgement of receipt of data frame X by node 1. Most, but not all, data frames in the 802.11 Standard do require acknowledgement of receipt because of the risk of non-delivery through collision or RF interference. Once it has been determined that acknowledgement of receipt is required by node 2, node 1 next checks to see whether there are any data frames queued for transmission, and which are intended for delivery to node 2. If there is at least one data frame, in this example labelled data frame Y, then node 1 concatenates the acknowledgement (ACK) frame 4 data frame X 120 received from node 2 with that data frame Y which is intended for node 2. The PLCP header of data frame Y (which would, in the prior art, be a header to data frame Y) is not required; addressing and other details are included in the PLCP header of the ACK frame instead.

Thus, a single, combined frame 140 is prepared for transmission by node 1. The combined frame 140 comprises a PLCP header 150, an acknowledgement frame 160 which acknowledges receipt of data frame X 120 from node 2, and a data frame Y 170 which is intended for delivery to the second node. This is transmitted from node 1 after a SIFS following receipt of the data frame X 120 with PLCP header 130.

The combined frame 140 is transmitted across the network and is received in the reception channel 210 of node 2. Node 2 recognizes that the frame 140 is a

combined frame (that is, a frame containing both an acknowledgement frame 160 for data frame X and also data frame Y 170, because the length of combined frame 140 is larger than that for a standard ACK frame in the 802.11 Standard. Once the frame 140 has been recognized as a combined frame, the acknowledgement information from acknowledgement frame 160 can be extracted and handled in the usual manner, and data frame Y 170 can likewise be extracted from the combined frame 140 again for onward passage in the usual manner.

It will be understood that, since most data frames require acknowledgement, mode 1 will in turn require acknowledgement of receipt of data frame Y when it has been received by node 2. In this case, the procedure described above is repeated. In other words, once node 2 has determined that an acknowledgement of receipt for data frame Y is necessary, it checks to see whether there are any queued data frames which need to be sent in the opposite direction, that is, back to node 1. When such a data frame, which for example is labelled data frame Z, is located in the queue at node 2, it is once again concatenated with the acknowledgement frame for data frame Y so as to produce a second combined frame 180 made up of a PLCP header 190, an acknowledgement frame 192 for data frame Y received from node 1, and data frame Z 194 intended for transmission back to node 1. This further combined frame 180 is transmitted from node 2 after a SIFS and is received in the reception channel 110 of node 1.

The procedure continues until there are no further data frames queued for a node requesting acknowledgement of receipt.

CLAIMS:

1. A method of handling data packets in a Wireless LAN network comprising:

receiving, at a first node in the network, an incoming data packet from a second node in the network;

preparing an acknowledgement of receipt by the first node, for return to the second node, when the incoming data packet is received at the first node; and

when it is ascertained that there is at least one outgoing data packet at the first node and which is intended for transmission to that second node, concatenating the acknowledgement of receipt with the or at least one of the outgoing data packets intended for that second node, for transmission as a combined data/acknowledgement packet to the second node.

2. The method of claim 1, wherein the acknowledgement of receipt comprises an IEEE 802.11 acknowledgement (ACK) frame.

3. The method of claim 2, wherein the or each outgoing data packet includes an IEEE 802.11 data frame.

4. The method of claim 3, wherein the or each outgoing data packet, and the acknowledgement of receipt, each has a Physical Layer Convergence Procedure (PLCP) Header prior to concatenation, and

wherein the step of concatenating comprises concatenating the data frame part of the outgoing data packet(s), without the PLCP Header, with the said ACK frame and its associated PLCP Header.

5. The method of any preceding claim, further comprising:

transmitting the combined data/acknowledgement packet from the first node;

receiving the combined data/acknowledgement packet at the said second node; and

at that second node, extracting the from the received, combined packet, the data which had been held in the at least one outgoing data packet at the first node, and/or extracting the acknowledgement of receipt issued by the first node.

6. The method of claim 5, wherein the step of extracting is carried out when it is determined by the said second node that the length of the combined data/acknowledgement packet is greater than that of an acknowledgement of receipt.

7. The method of claim 6, further comprising:

preparing, at the second node, a further acknowledgement of receipt of the combined data/acknowledgement packet at that second node; and

when it is ascertained that there is at least one outgoing data packet at the second node and which is intended for transmission to that second node, concatenating that further acknowledgement of receipt

with the, or at least one of the, outgoing data packets intended to be sent to the first node, for transmission as a further combined data/acknowledgement packet back to the first node.

8. The method of any of the preceding claims, wherein the acknowledgement of receipt by the first node is prepared and concatenated only when the second node requests such an acknowledgement.

9. A method of handling data packets in a WLAN substantially as hereinbefore described with reference to the accompanying drawings.

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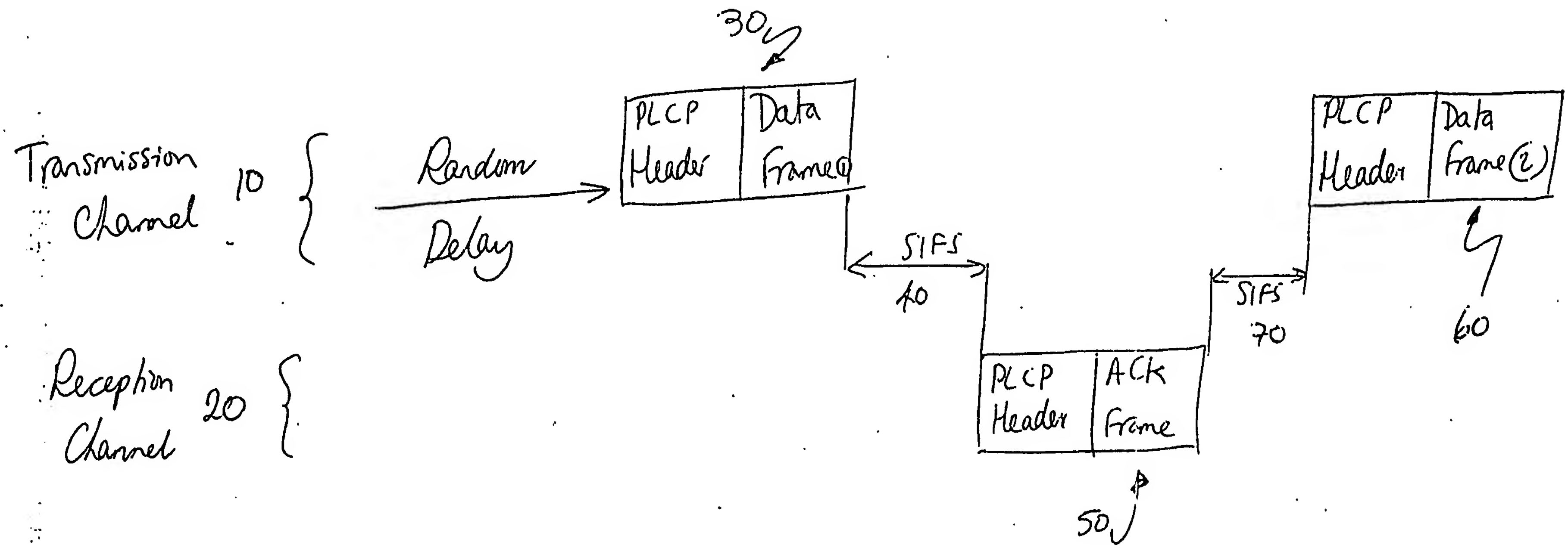

FIG. 1

PRIOR ART

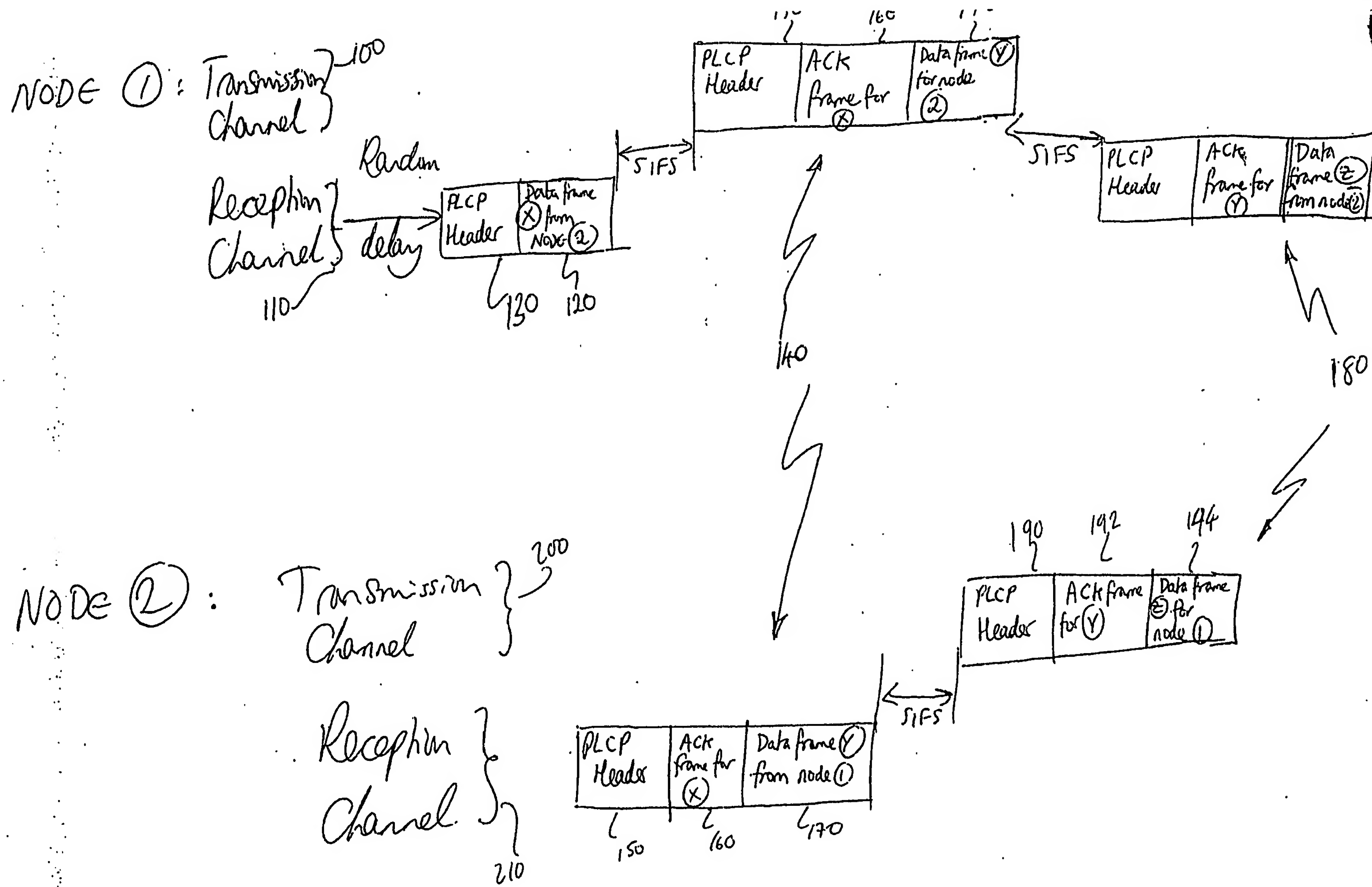
NODE 1: Transmission Channel 100
Reception Channel 110
Random delay
PLCP Header
Data frame X from NODE 2
130
120
SIFS
PLCP Header
ACK frame for X
Data frame Y for node 2
160
140
SIFS
PLCP Header
ACK frame for Y
Data frame Z from node 2
180
NODE 2: Transmission Channel 200
Reception Channel 210
PLCP Header
ACK frame for X
Data frame Y from node 1
150
160
170
SIFS
PLCP Header
ACK frame for Y
Data frame Z for node 1
190
192
194

FIG. 2.

Document made available under the Patent Cooperation Treaty (PCT)

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